

Special Report 87-16

August 1987



12

DTIC FILE COPY

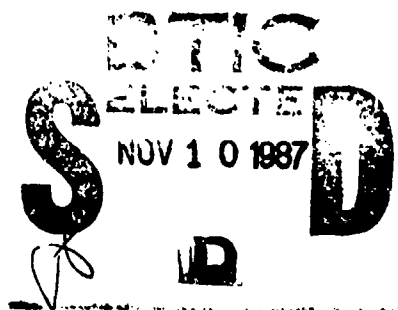
US Army Corps
of Engineers

Cold Regions Research &
Engineering Laboratory

Evaluation of the Shasta waterless system as a remote site sanitation facility

C. James Martel

AD-A186 000



Prepared for
OFFICE OF THE CHIEF OF ENGINEERS

Approved for public release; distribution is unlimited.

87 10 27 058

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188
Exp. Date: Jun 30, 1986

1a. REPORT SECURITY CLASSIFICATION Unclassified			1b. RESTRICTIVE MARKINGS A186000		
2a. SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.		
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE					
4. PERFORMING ORGANIZATION REPORT NUMBER(S) Special Report 87-16			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION U.S. Army Cold Regions Research and Engineering Laboratory		6b. OFFICE SYMBOL (If applicable) CECRL		7a. NAME OF MONITORING ORGANIZATION Office of the Chief of Engineers	
6c. ADDRESS (City, State, and ZIP Code) Hanover, New Hampshire 03755-1290			7b. ADDRESS (City, State, and ZIP Code) Washington, D.C. 20314-1000		
8a. NAME OF FUNDING / SPONSORING ORGANIZATION		8b. OFFICE SYMBOL (If applicable)		9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c. ADDRESS (City, State, and ZIP Code)			10. SOURCE OF FUNDING NUMBERS		
			PROGRAM ELEMENT NO. 6.27.20A	PROJECT NO. 4A7627 20A896	WORK UNIT ACCESSION NO. B 049
11. TITLE (Include Security Classification) Evaluation of the Shasta Waterless System as a Remote Site Sanitation Facility					
12. PERSONAL AUTHOR(S) Martel, C. James					
13a. TYPE OF REPORT		13b. TIME COVERED FROM _____ TO _____		14. DATE OF REPORT (Year, Month, Day) August 1987	
				15. PAGE COUNT 39	
16. SUPPLEMENTARY NOTATION					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP	Cold regions		
			Latrines;		
			Sanitary engineering;		
			Waterless sanitation systems		
19. ABSTRACT (Continue on reverse if necessary and identify by block number) The waterless toilet manufactured by Shasta Manufacturing, Inc., of Redding, California, was evaluated for possible use at remote military training sites and guard stations. A telephone survey of six recreational areas indicated that park personnel were generally pleased with the performance of these units. On-site visits did not encounter offensive odors. Proper ventilation and liquid level control were found to be key factors in successful operation. A rational approach to sizing these units was developed on the basis of local pan evaporation rates. <i>Keywords: Toilet facilities waste disposal</i>					
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION Unclassified		
22a. NAME OF RESPONSIBLE INDIVIDUAL C. James Martel			22b. TELEPHONE (Include Area Code) 603-646-4100		22c. OFFICE SYMBOL CECRL-EC

PREFACE

This report was prepared by C. James Martel, Environmental Engineer, Civil Engineering Research Branch, Experimental Engineering Division, U.S. Army Cold Regions Research and Engineering Laboratory.

Technical review was provided by Richard J. Scholze of the U.S. Army Construction Engineering Research Laboratory, Champaign, Illinois; Michael E. Jensen of the U.S. Department of the Interior, National Park Service, Denver, Colorado; and Chet Sunde, Director of Marketing, Shasta Manufacturing Inc., Redding, California.

Funding for the study described in this report was provided by DA Project 4A762720A896, Environmental Quality Technology, Task B, Environmental Design and Construction, Work Unit 049, Self-Contained Waste Management for Military Facilities in Cold Regions.

The contents of this report are not to be used for advertising or promotional purposes. Citation of brand names does not constitute an official endorsement or approval of the use of such commercial products.

CONTENTS

	<u>Page</u>
Abstract	1
Preface	11
Introduction	1
Description and operation	2
Evaluation of performance	6
Shenandoah National Park	7
Tongass National Forest	8
Englebright Lake	9
Proposed new size selection procedure	13
Example	16
Problem	16
Solution	16
Conclusions and recommendations	17
Literature cited	18
Appendix A: Waterless sanitation systems telephone survey questionnaire.	19

ILLUSTRATIONS

Figure

1. Major components of a Shasta unit	3
2. Configuration of assembled components	4
3. Shasta unit at Shenandoah National Park, Virginia	7
4. Shasta unit at Tongass National Forest, Alaska	8
5. Installation of 250-gal. Shasta unit at Englebright Lake, California	10
6. Selected Shasta units in California	12
7. Normal annual Class A pan evaporation in inches	15

TABLES

Table

1. Cost, advantages and disadvantages of available technologies ..	5
2. Cost comparison of various Shasta unit alternatives to satisfy usage rate of approximately 6570 uses/yr	17



Accession For	
NTIS	<input checked="" type="checkbox"/>
CRA&I	<input type="checkbox"/>
DTIC	<input type="checkbox"/>
TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution /	
Availability Codes	
Dist	Avail and/or Special
A-1	

EVALUATION OF THE SHASTA WATERLESS SYSTEM AS A REMOTE SITE SANITATION FACILITY

by

C. James Martel

INTRODUCTION

Sanitary facilities at remote military training areas have traditionally consisted of pit privies and vault latrines. These facilities have proven to be functional but are often unpleasant to use because of obnoxious odors. Also, maintenance of these facilities can be difficult if they are located at remote sites. Chemical toilets have been used in place of pit privies and vault latrines, but these units are expensive to maintain because of frequent pumping requirements. New technologies are commercially available that could replace these traditional technologies at a reasonable cost.

The U.S. Army Construction Engineering Research Laboratory (CERL) conducted an extensive literature review and field survey of several alternative systems (Smith et al. 1984). As a result, the aerated vault latrine and the composting toilet were selected for further research and demonstrations (Scholze et al. 1986). These studies concluded that aerated vault latrines were most cost effective when vaults were already constructed and power was available. Composting toilets were recommended for areas where power was unavailable but not for use in cold climates because of a significant reduction in composting rates. Also, composting toilets were found to be expensive and require careful maintenance.

As an alternative to composting toilets for remote locations, the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) decided to evaluate a new product called the Waterless Sanitation System manufactured by Shasta Manufacturing Inc. of Redding, California. The company claims that this system is practically odor free, simple to install, and easy to maintain. It is available in four sizes depending on the usage rate. Including a prefabricated toilet building, the cost of each unit ranges from \$1900 to \$3250. Shasta Manufacturing Inc. is the patent holder of this technology and sole source for acquisition.

To evaluate this technology, several users in the U.S. Army Corps of Engineers, National Park Service and the U.S. Department of Agriculture were interviewed in a telephone survey. This survey was followed by visits to three operational sites. The Shasta Manufacturing Co. was visited to obtain product information and design guidelines. Also, a rational method was developed to predict the allowable usage rate for any climate. However, this method has not been verified.

DESCRIPTION AND OPERATION

The Waterless Sanitation System or Shasta unit has three major components: a holding tank, a slotted basket and a toilet building. These components are shown in Figure 1. The holding tank is made of reinforced fiberglass and is available in four models: 140, 250, 350 and 500 gal. The basket is also made of fiberglass but is smaller in diameter and depth so that it can be suspended within the tank.

Both tank and basket are installed in the ground with the toilet building placed on top (see Fig. 2). For proper installation care should be taken to seal around the toilet building in order to prevent surface runoff from entering the holding tank. The "Californian" pre-fabricated structure made by Shasta has a specially designed floor that forms a tight seal around the tank. Also, care must be taken when backfilling around the tank to avoid deformation. A deformed tank can restrict airflow around the basket and interfere with basket removal.

A unique feature of this system is the separation of solids from the liquids. The solids are retained in the basket while the liquids drain into the underlying holding tank via the slots in the basket. According to manufacturer's literature, this separation promotes aerobic decomposition of solids and evaporation of liquids. If this separation is not maintained, the system will fail in that anaerobic decomposition will occur and obnoxious odors will be generated.

The manufacturer claims that most of the liquids in the holding tank can be removed by natural evaporation. This feature is especially attractive for remote sites where vehicle access can be difficult. Any remaining liquids can be removed through the optional pump-out pipe. If subsurface discharge is allowed at the site, liquid level control can be achieved by



a. Tank and slotted basket.



b. Toilet building.

Figure 1. Major components of a Shasta unit.

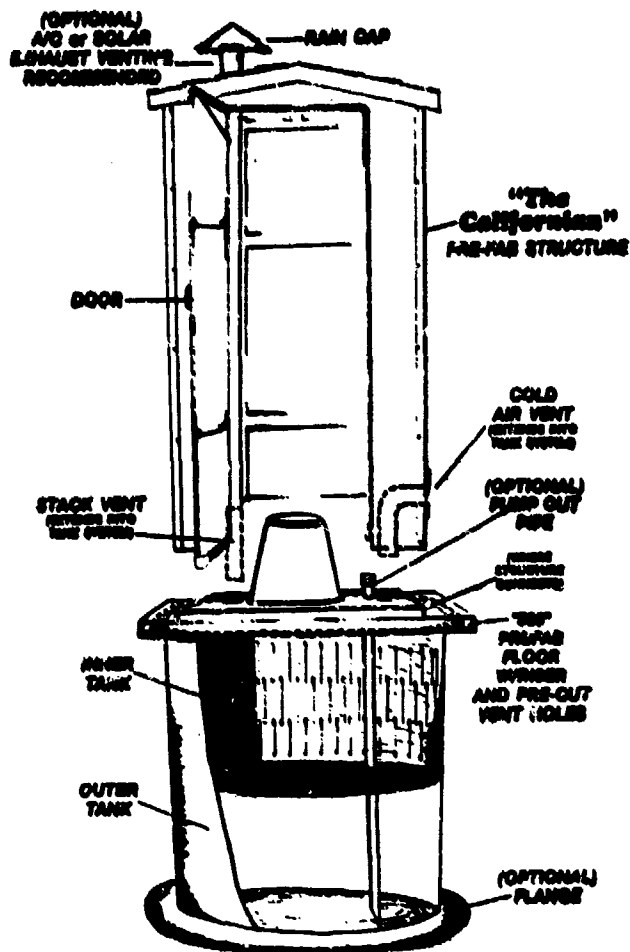


Figure 2. Configuration of assembled components.

installing a drain pipe at an elevation just below the bottom of the basket.

Periodic solids removal can be accomplished by removing the toilet building and lifting the basket out of the tank. This operation will require mechanical equipment such as a tripod and block and tackle. In accessible areas, solids can be removed by flushing the unit and removing the resulting slurry with a conventional septic tank pump truck.

Ventilation is critical to the performance of these units. Without adequate ventilation, the solids will not decompose aerobically and the liquids will not evaporate. The system was designed to operate on natural ventilation only. However, the manufacturer recommends forced ventilation whenever possible. Electrical (a.c.) and solar-powered (d.c.) vent fans are available as options.

A comparison of costs, advantages and disadvantages of the Shasta unit with other remote site waste treatment technologies is shown in Table 1.

Table 1. Cost, advantages and disadvantages of available technologies^a.

	Pit latrine	Vault latrine	Chemical Latrine (Port-a-Pot)	Aerated vault latrine	Composting latrine	Shasta latrine
Initial cost	\$10,000	\$12,000 to \$15,000	None	\$2,000 (Retrofit) \$14,000 to \$17,000 (new)	\$13,500 (without solar power option) \$4990	\$1170 to \$2250 \$1900 to \$3250 with toilet building. Depends on pumping rate. Approx. \$100 if pumped once/yr.
Annual operation and maintenance costs ^b	\$640 (Relocation labor)	\$900	\$1,820 (Rental fee)	\$1,250		
Annual energy costs (\$ 10/kWh) ^c	----	----	----	\$480	\$24 (30 with solar power option)	\$0 with natural ventilation or solar powered vent fan \$25 with A/C vent fan.
Capacity (persons/day)	100	100	10	100	25	3 to 40 depending on size of unit.
Advantages	Low maintenance costs. Simple system.	Simple system.	Portable. No upkeep (when re-filled).	Uses existing facilities. Easy retrofit. Improves aesthetics.	No treatment plant required. Low energy requirements. Adaptable to extremely remote areas.	Low cost. No offensive odors. Easy to maintain. Little or no energy required.
Disadvantages	Environmentally hazardous. Aesthetically unpleasing. Presents health risks.	High operation and maintenance costs. Aesthetically unpleasing. Presents health risks. Hard on treatment plants.	Hard on treatment plant. Vandal prone. Low capacity.	Relatively high maintenance costs. Still requires further treatment.	High first cost. Some precautions required (no lit cigarette, no trash). Maintenance critical.	Offensive odors if over-loaded. Lack of rational size selection procedure. Difficulties in manual solids removal.

^a Information on pit, vault and chemical latrines was obtained from Smith et al. (1980) and Scholze et al. (1980).

^b Present worth value on a 10-year capacity basis (includes all operation and maintenance labor and materials, and first and replacement parts costs). Assumes: \$20/hr contracted labor cost, \$8.50/hr troop labor cost, \$0.10/kWh energy cost, 10% discount rate, 20-year life except 5-year life on motor/blower unit used for vault aeration.

^c These costs were tabulated based on the best available information from a limited number of installations and do not necessarily represent conditions on all Army installations.

Overall, the Shasta units are very competitive both in cost and in the advantages they offer. The main disadvantage is the lack of a rational design approach, which makes it difficult to select the proper unit.

EVALUATION OF PERFORMANCE

There is little published information on the performance of Shasta units. However, the National Park Service (Jensen 1984) recently completed an extensive study of several 500-gal. units located in Wyoming (Fossil Butte National Monument), and Arizona (Glen Canyon National Recreation Area and Grand Canyon National Park). This study reported fly and odor problems with several units after only one or two years of operation. Overloading and poorly installed ventilation systems were cited as the main causes. In an attempt to correct this situation, some units were modified by installing a solar vent fan, drain pipe, and a urinal. The purpose of the urinal was to keep the solids in the basket drier by diverting the urine into the holding tank. According to Jensen*, these modifications were working well but the solids were accumulating faster than anticipated. Since there is no vehicle access to the area, cleanout of the basket must be accomplished by hand, which is an unpopular task among maintenance personnel.

A telephone survey (see App. A) was conducted to learn more about the performance of these units at six other locations. Generally, the survey found that park rangers and managers were pleased with their Shasta units. The only complaint came from a ranger at the Car-Gatineau Park in Ontario, Canada, who reported a slight odor problem. According to the manufacturer, these odors were caused by a poor vent design. The toilet buildings used at the Car-Gatineau Park were locally manufactured and did not meet specifications for ventilation. This problem was solved by redesigning the ventilation system.

Three on-site visits were conducted to observe firsthand the performance of Shasta units under various climatic conditions. The first site was in a hot and humid climate (Shenandoah National Park, Virginia), the second in a cold and humid climate (Tongass National Forest, Alaska) and the third

*Personal communication with M.E. Jensen, Environmental Sanitation Consultant, National Park Service, Denver Colorado, 22 Dec. 1986.

in a dry, temperate climate (Englebright Lake, California). None of the units had forced ventilation systems. The following is a brief account of my observations at each of these sites.

Shenandoah National Park

On 19 July 1984 I met with Donald Jenkins and Mary Ellis of the National Park Service. We visited a 250-gal. Shasta unit located near Bearfence Mountain. This unit was installed in 1982 to replace a pit toilet, which had been difficult to relocate in the rocky terrain. The toilet building used with the pit was placed over the Shasta tank and basket. Although the building was structurally sound, it did not appear to be properly sealed around the base to prevent surface runoff from entering the holding tank nor was it vented properly. To prevent the tank from flooding, a drain pipe was installed just below the basket level. This drain pipe daylighted to a wooded area about 25 ft downslope. The end



Figure 3. Shasta unit at Shenandoah National Park, Virginia.

of the drain pipe was screened to prevent animal intrusion. The ground beneath the end of the drain pipe was wet, indicating that either condensation or liquid discharge from the tank had occurred. Figure 3 is a photograph of the unit.

During my visit I noticed only a slight odor in the vicinity of the unit. A bucket of lime was provided as an aid for odor control. Mr. Jenkins stated that he had no problems with this unit during two full years of operation.

Tongass National Forest

On 11 October 1985 I visited a 500-gal. Shasta unit near the shores of Lake Eva, 25 miles north of Sitka, Alaska. This unit was located about 100 ft from a log cabin that accommodates about 200 to 300 people per year during the summer months (130 days in 1984). A locally made wooden toilet building was placed over the Shasta unit (see Fig. 4). Although the build-



Figure 4. Shasta unit at Tongass National Forest, Alaska.

ing was well ventilated, there was little ventilation in the unit because no vent pipes went into the tank and basket. Consequently, the basket was about half full with moist solids, indicating that dehydration was not taking place. Despite this deficiency, only a slight odor could be noticed near the unit.

According to Thomas Keyes of the U.S. Forest Service, the unit filled with liquids after two seasons. It was emptied by first pumping water into the tank to resuspend the solids. The contents were then removed with a diaphragm pump and discharged and buried in a pit located behind the toilet building. Mr. Keyes concluded that some decomposition and evaporation had occurred but not enough to keep the vault from filling. Overall he was satisfied with the Shasta unit.

Englebright Lake

Located near Sacramento, California, Englebright Lake Recreation Area is operated by the U.S. Army Corps of Engineers. In March of 1986, I met with Douglas Grothe, Park Manager, who was in the process of installing 20, 250-gal. units and 10, 140-gal. units around the lake. He explained that the main reasons for selecting Shasta units were that they were lower in maintenance cost than the previously used chemical toilets, and they protected the groundwater which feeds into the lake. Figure 5 shows the installation of a 250-gal. holding tank.

During the first summer of operation, 5 or 6 of the 140-gallon units had to be pumped out because of solids accumulation*. According to the manufacturer† these units were utilized far in excess of their capacity. Instead of slumping and spreading out in the basket as expected, the solids accumulated into a cone-shaped pile. In some cases this pile attained such a height that it protruded into the lower portion of the toilet riser. This situation did not make for pleasant use of the unit because of the visible solids so near the toilet seat. Even though the solids accumulated excessively, there was no indication of a liquid overload.

Although little odor was noticeable on the inside of the toilet building, Mr. Grothe reported that some odors did linger in the vicinity. It

*Personal communication with D. Grothe, Park Manager, Englebright Lake Recreation Area, 1986.

†Personal communication with C. Sunde, Director of Marketing, Shasta Corporation, 1986.



a. Lowering tank into hand-dug hole.



b. Leveling tank.

Figure 5. Installation of 250-gal. Shasta unit at Englebright Lake, California.



c. Installing forms for concrete base.

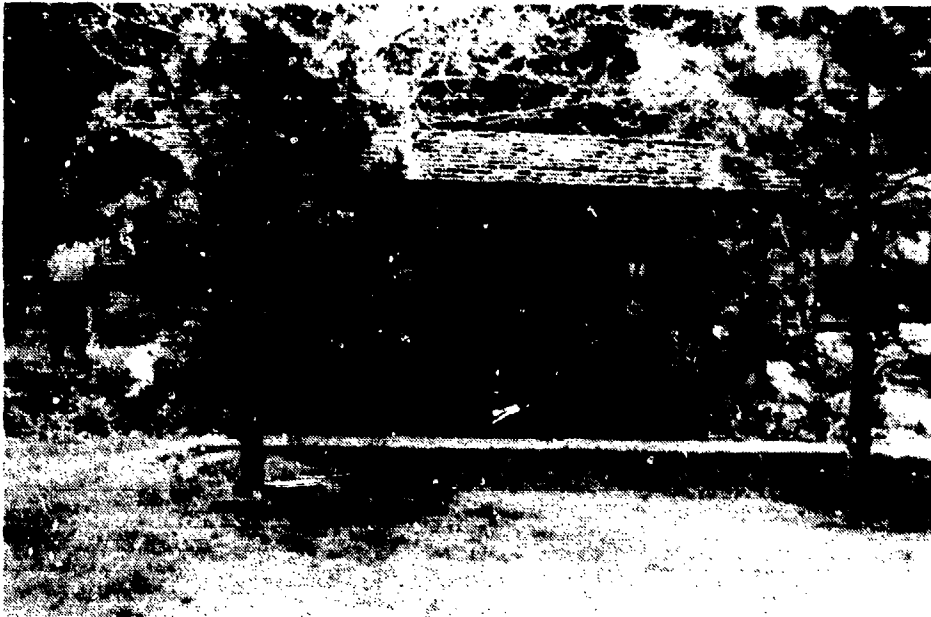


d. Tank and base before installation of basket and toilet building.

Figure 5 (cont'd). Installation of 250-gal. Shasta unit at Englebright Lake, California.



a. Ball's Ferry County Park.



b. French Gulch.

Figure 6. Selected Shasta units in California.

should be noted that some of these units were located in sheltered areas with abundant foliage overhead and little wind. All other Shasta units were reported to be functioning well.

While in the northern California area, I visited Ball's Ferry County Park which had two 250-gal. units. Installed three years ago, these units had never been pumped out. Inspection of the units indicated that the solids in one of the baskets were saturated but little odor was evident. This particular installation did not have a protective rain cap on the stack vent. Moisture could have entered the basket via the vent during a large rainstorm that preceded my inspection.

I also visited a site (French Gulch) which had been in operation for five years. Again there were no odors and the solids in the basket did not appear to be saturated. These sites are shown in Figure 6.

On the basis of the telephone survey and site visits, I concluded that the Waterless Sanitation System manufactured by Shasta was a feasible alternative for remote site waste treatment. However, for the units to operate properly they must be properly ventilated (forced ventilation is recommended) and not overloaded. Overloading occurs whenever the liquid level reaches the solids in the basket or the solids fill the basket. Of these two possibilities, control of the liquid level appears to be most critical. To control the liquid level, the unit must be sized such that the usage rate will never exceed the evaporation rate or the planned pump-out rate.

PROPOSED NEW SIZE SELECTION PROCEDURE

Currently, the method used to select the unit needed for a particular usage rate is more of an art than a science. The manufacturer specifies usage rates for each unit but these rates do not change according to local variations in evaporation rates. This is unrealistic because a unit located in a humid environment will not evaporate as much liquid as one located in a dry environment. The manufacturer is aware of potential variations in usage rates but has no way to account for them in the present selection procedure. A more rational approach is needed that will take this factor into account.

If liquid removal is assumed to be by evaporation only, then the unit could be designed to operate without pumping if the annual usage rate

matched the annual evaporation rate. Mathematically, this equality can be expressed as

$$NV = 7.48 A E \quad (1)$$

where

N = average number of uses per year

V = average volume of urine per use, gal.

7.48 = conversion factor, ft^3 to gal.

A = liquid surface area in tank, ft^2

E = average annual depth of liquid evaporated from tank, ft.

Solving for N, eq 1 becomes

$$N = \frac{7.48 A E}{V} \quad (2)$$

The values of A are 9.0, 7.9, 7.9 and 19.6 ft^2 for the 140-, 250-, 350- and 500-gal. units, respectively. Note that the surface area of the 140-gal. unit is larger than that of both the 250- and 350- gal. units. Therefore, on the basis of liquid removal by evaporation alone, the 140-gal. unit will allow a greater usage rate. However, the 250- and 350-gal. units have a greater storage capacity, which can be important if the usage pattern varies widely or pumping is planned.

According to Fair et al. (1968) the average quantity of urine generated per person is 0.3 gal. per day. Assuming six uses per day, a reasonable estimate of V is 0.05 gal. per use. Substituting for V and A in eq 2, N can be calculated from the following relationships:

$$N = 1346 E \text{ for a 140-gal. unit} \quad (3)$$

$$N = 1182 E \text{ for a 250- or 350-gal. unit} \quad (4)$$

$$N = 2932 E \text{ for a 500-gal. unit.} \quad (5)$$

The only unknown in the above equations is E, the average annual rate of evaporation from the in-ground storage tank. No information on E was found in the literature since the in-ground configuration is unique to this application. Also, the manufacturer was unable to provide these data. However, there is a readily available data base on pan evaporation kept by the National Oceanic and Atmospheric Administration (NOAA). Pan evaporation is measured with a standard class A pan, which is a circular vessel constructed of unpainted galvanized iron, 4 ft in diameter and 10 in. deep. The pan is placed on a wooden frame 6.0 in. above the ground surface. It is filled with 8 in. of water, and the change in depth due to

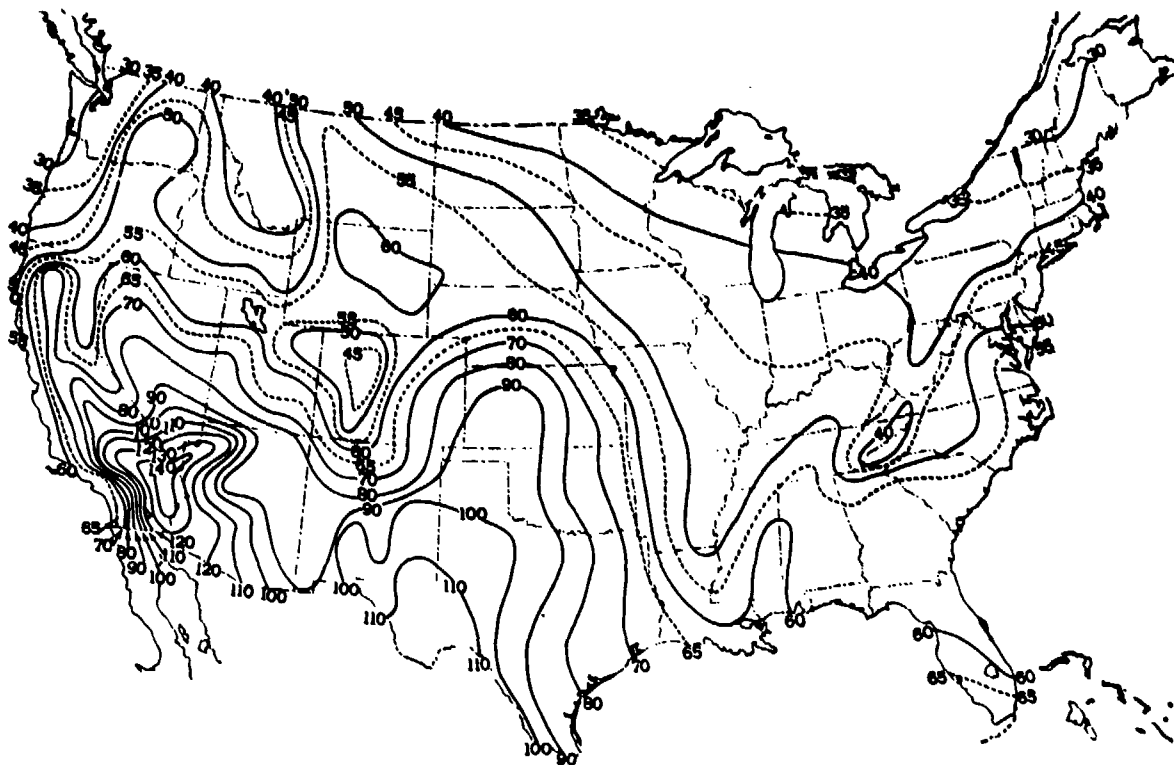


Figure 7. Normal annual Class A pan evaporation in inches (Linsley et al. 1958).

evaporation is measured daily. Isolines of mean annual pan evaporation in the U.S. are shown in Figure 7.

For design purposes it may be possible to estimate a value of E based on the average annual pan evaporation at the intended site. This approach has been used to estimate lake evaporation. A commonly accepted pan coefficient for lake evaporation is 0.70. For example, the estimated lake evaporation is 21 in. for a site where the average annual pan evaporation is 30 in. The pan coefficient for tank evaporation should be less than for lake evaporation because the liquid surface in the holding tank is shaded and below ground level, a condition which is not conducive to evaporation. Even with a vent fan it is doubtful that air movement over the surface will equal that of an average wind over an open lake. More research is needed to determine this coefficient before this sizing procedure can be implemented.

If a single unit is not large enough to accommodate the anticipated use, the designer has a choice of either adding more units or pumping out the single unit on a regular basis. If more units are added, precautions

must be taken to distribute usage evenly between the units. Otherwise some units will become overloaded and odors will be produced. One way of avoiding this situation would be to install multiple units at the same elevation and interconnect each tank with a pipe.

Removing the liquid from the tank is another way to increase the number of uses. Assuming a 2.0-in. separation between the bottom of the basket and the liquid surface, the 140-, 250-, 350- and 500-gal. units have storage capacities of 2%, 84, 241 and 269 gal., respectively. At 0.05 gal. per use, these capacities translate into 440, 1680, 4820 and 5380 uses per pump-out.

EXAMPLE

A sanitation facility is needed for a remote guard station at Ft. Drum, N.Y. This station will be manned by two guards on a 24-hour basis for 365 days per year.

Solution

Based on three uses per person per 8-hr shift, the estimated annual usage rate is

$$\frac{3 \text{ uses}}{\text{person}} \times \frac{2 \text{ persons}}{\text{shift}} \times \frac{3 \text{ shifts}}{\text{day}} \times \frac{365 \text{ da}}{\text{yr}} = \frac{6570 \text{ uses}}{\text{yr}} .$$

From Figure 7 the mean annual pan evaporation rate in the Ft. Drum area is approximately 35 in. Based on previous discussions the pan coefficient for tank evaporation is estimated to be 0.50. Therefore, the E value for Ft. Drum will be 17.5 in. (1.45 ft). Substituting this E value in eq 3, 4 and 5,

$$N = 1346 \times 1.45 = 1952 \text{ uses/yr for a 140-gal. unit}$$

$$N = 1182 \times 1.45 = 1714 \text{ uses/yr for a 250- or 350-gal. unit}$$

$$N = 2932 \times 1.45 = 4251 \text{ uses/yr for a 500-gal. unit.}$$

None of the units is large enough to handle the estimated annual usage rate of 6570 uses/yr. However, as mentioned earlier, higher usage rates can be managed by increasing the number of units or pumping out the unit on a regular basis. For example, two 500-gal. units would provide 8502 uses/yr. Also, one 500-gal. unit pumped once each year would provide 9631 uses/yr (4251 uses/yr from evaporation and 5380 uses per pump-out).

Seven alternative management schemes are shown in Table 2. The first three involve installing multiple units of the same size and allowing

Table 2. Cost comparison of various Shasta unit alternatives to satisfy usage rate of approximately 6570 uses/yr.

Alternative	Uses/yr	Capital cost*, (\$)	Annual† pumping cost \$/yr	Amortized** annual cost \$	Total annual cost \$/yr
1) Install two 500-gal. units	8502	6,657	0	992	992
2) Install four 140-gal. units	7808	8,975	0	1338	1338
3) Install four 250-gal. units	6856	10,764	0	1604	1604
4) Install one 500-gal. unit and pump once/yr	9631	3,328	100	496	596
5) Install one 350-gal. unit and pump once/yr	6534	2,796	100	417	517
6) Install one 250-gal. unit and pump three times/yr	6754	2,691	300	402	702
7) Install one 140-gal. unit and pump eleven times/yr	6792	2,244	1100	334	1434

* Includes waterless sanitation system, flange, toilet building, pump-out pipe, toilet riser and solar exhaust fan.

† Based on estimated cost of \$100.00 per pump-out

**Based on 10 years at 8%

evaporation alone to remove the liquids. The last four alternatives involve emptying the units one or more times per year, depending on the size of the unit. The economic analysis shown in Table 2 indicates that the pumping alternatives (4, 5 and 6) are considerably less expensive than the multiple unit alternatives (1, 2 and 3). The least expensive is alternative 5, which has a total annual cost of \$517. Nevertheless, alternative 4 may be a better option because it provides an extra 3097 uses/yr for a minimal additional annual cost of \$79.00.

CONCLUSIONS AND RECOMMENDATIONS

The Shasta Waterless Sanitation System is a feasible alternative as a remote site sanitation facility. It is most suited for arid climates where

the evaporation rate is high. It can also be used in humid and cold areas but the usage rate will be reduced. It should be considered for small unit training areas, guard stations and other remote applications in lieu of pit vault and chemical latrines.

More research is needed to estimate the rate of evaporation from the in-ground storage tank. This rate could then be correlated with pan evaporation so that a pan coefficient can be determined. With this information, a more rational approach to size selection would be possible. Otherwise the purchaser of Shasta units is left to the discretion of the manufacturer for selecting the proper size and number of units.

LITERATURE CITED

Fair, M.F., J.C. Geyer and D.A. Okun (1968) Water and wastewater engineering, vol. 2, New York: John Wiley and Sons.

Jensen, M.E. (1984) Remote area toilet facilities, experiences and observations, 1983 and 1984. Report to National Park Service, Washington, D.C.

Linsley, R.K., M.A. Kohler and J.L. Paulhaus (1958) Hydrology for engineers. New York: McGraw Hill.

Scholze, R.J., J.E. Allman, S.R. Struss and E.D. Smith (1986) Technology for waste treatment at Army remote sites. U.S. Army Construction Engineering Research Laboratory Technical Report N-86/20, Champaign, Illinois.

Smith, E.D., C.P.C. Poon, S.R. Struss, J.T. Bandy and R.J. Scholze (1984) Appropriate technology for treating wastewater at remote sites on Army installations: Preliminary findings. U.S. Army Construction Engineering Research Laboratory Technical Report N-160, Champaign, Illinois.

APPENDIX A
WATERLESS SANITATION SYSTEMS
TELEPHONE SURVEY QUESTIONNAIRE

LOCATION: U.S. Forest Service TEL. NO. (916) 534-6500
Plumas National Forest CONTACT: Dewey G. Riscioni
Oroville Ranger District DATE: _____
875 Mitchell Avenue
Oroville, CA 95965-4699

UNIT SPECIFICATIONS

Size (gal.): 250
Quantity: 5
Years of Use: 3 to 4
Estimated Daily Use (#/day): 2 remote, 20-25 people/wk
2 on traveled route, 15-50 people/day
Seasonal Use (mo.): 5

OPERATION AND MAINTENANCE

Visit once/wk to bring toilet paper and clean.
No pumping required on 4-yr-old units.
Remove beer cans in the spring.

AESTHETICS

No odors or flies.

ADDITIONAL COMMENTS

Very pleased with system.

**WATERLESS SANITATION SYSTEMS
TELEPHONE SURVEY QUESTIONNAIRE**

LOCATION: U.S. Dept. of Agriculture TEL. NO. (907) 747-6671 ext. 277
Tongass Nat'l Forest CONTACT: Tom Keyes
P.O. Box 1980, Sitka, AK 99835 DATE: 30 April 85

UNIT SPECIFICATIONS

Size (gal.): 500
Quantity: 1
Years of Use: 3 yr
Estimated Daily Use (#/day): 4 people/day
Seasonal Use (mo.): 4

OPERATION AND MAINTENANCE

Estimate basket to be 1/2 full of solids.
No garbage.
Liquid may have to be pumped.
Expect little evaporation - 100 in. rain/yr.

AESTHETICS

No odor problem.

ADDITIONAL COMMENTS

Wilderness area - access by float plane.

**WATERLESS SANITATION SYSTEMS
TELEPHONE SURVEY QUESTIONNAIRE**

LOCATION: Army Corps of Engineers TEL. NO. (602) 462-7581
Lake Mendocino CONTACT: Jim W. Welcher
1160 Lake Mendocino DATE: _____
Ukiah, CA 95482

UNIT SPECIFICATIONS

Size (gal.): 250
Quantity: 3
Years of Use: 2
Estimated Daily Use (#/day): 80 people/day during week
200 people/day on weekend
Seasonal Use (no.): 8

OPERATION AND MAINTENANCE

Problems with beer cans and tampon applicators - remove with long handle clamp. Ventilation critical - used turbine aerators.

AESTHETICS

No odor problems in over 2 years.

ADDITIONAL COMMENTS

Very positive opinion of system.

**WATERLESS SANITATION SYSTEMS
TELEPHONE SURVEY QUESTIONNAIRE**

LOCATION: Army Corps of Engineers TEL. NO. (707) 433-9483
Warm Springs Dam CONTACT: Jim Anders
3333 Skaggs Springs Road DATE: 4/30/83
Geyserville, CA 95441

UNIT SPECIFICATIONS

Size (gal.): 250
Quantity: 4
Years of Use: 4
Estimated Daily Use (#/day): 30-75 people/day.
Seasonal Use (mo.): 8

OPERATION AND MAINTENANCE

Install tank with proper drainage so it won't fill with rainwater.

AESTHETICS

Odorless

ADDITIONAL COMMENTS

Heavy rains - consider putting cap over vent.

WATERLESS SANITATION SYSTEMS
TELEPHONE SURVEY QUESTIONNAIRE

LOCATION: Shenandoah National Forest TEL. NO. (703) 999-2243
Rt. 4 Box 292 CONTACT: Don Jinkins
Luray, VA 22835 DATE: 5/1/85

UNIT SPECIFICATIONS

Size (gal.): 250
Quantity: 4
Years of Use: 2
Estimated Daily Use (#/day): 10 people/wk each unit (est.)
Seasonal Use (mo.): 8

OPERATION AND MAINTENANCE

Systems are performing as advertised. Systems were modified by attaching a 2 in. PVC pipe to the outer tank and venting to daylight. The pipe acted as a vent and an overflow if necessary. There was a concern that evaporation in the humid East would not be able to control liquid depth. However, there have been no problems yet.

AESTHETICS

No odor problems.

ADDITIONAL COMMENTS

Generally satisfied with system. No data on the amount of solids buildup in inner basket.

LOCATION: Car-Gatineau Park TEL. NO. (819) 827-2711
National Capital Commission CONTACT: Phillip Lauzon
161 Laurier Avenue West DATE: _____
Ottawa Ontario, Canada K1P 6J6

24